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ROLE OF MEDICAL THERMOGRAPHY IN DETECTING NEUROPATHIC PAIN AND NERVE DYSFUNCTION

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Abstract
Medical thermography, particularly digital infrared thermal imaging, has emerged as a promising non-invasive diagnostic modality in neurology and pain medicine. Neuropathic pain and nerve dysfunction are frequently associated with abnormalities in autonomic regulation, vascular control, and tissue metabolism, all of which influence skin temperature distribution. Infrared thermography detects these changes by measuring emitted infrared radiation from the body surface. The physiological basis, clinical applications, diagnostic significance, advantages, limitations, and future perspectives of medical thermography in detecting neuropathic pain and nerve dysfunction.

Keywords: Infrared thermography, neuropathic pain, nerve dysfunction, digital infrared thermal imaging, diabetic neuropathy, autonomic nervous system.

Introduction

Neuropathic pain is defined as pain caused by a lesion or disease affecting the somatosensory nervous system [1]. Unlike nociceptive pain, neuropathic pain results from abnormal neural activity and is often characterized by burning sensations, tingling, allodynia, hyperalgesia, and spontaneous pain [2]. Diagnosing neuropathic disorders remains clinically challenging because conventional imaging techniques may fail to demonstrate early functional abnormalities [3-14].

Medical thermography has emerged as a valuable complementary diagnostic method due to its ability to evaluate physiological changes associated with autonomic dysfunction and vascular abnormalities [3]. Infrared thermography measures the infrared radiation naturally emitted by the human body and converts it into visual thermal maps known as thermograms [4]. Since skin blood flow is regulated by the autonomic nervous system, disturbances in nerve function can produce detectable thermal asymmetry [6].

Recent technological advances in digital infrared thermal imaging, image-processing software, and computer-assisted analysis have improved the accuracy and clinical applicability of thermographic assessment [15]. Consequently, thermography is increasingly investigated in neurology, rehabilitation medicine, diabetic care, and pain management [16].

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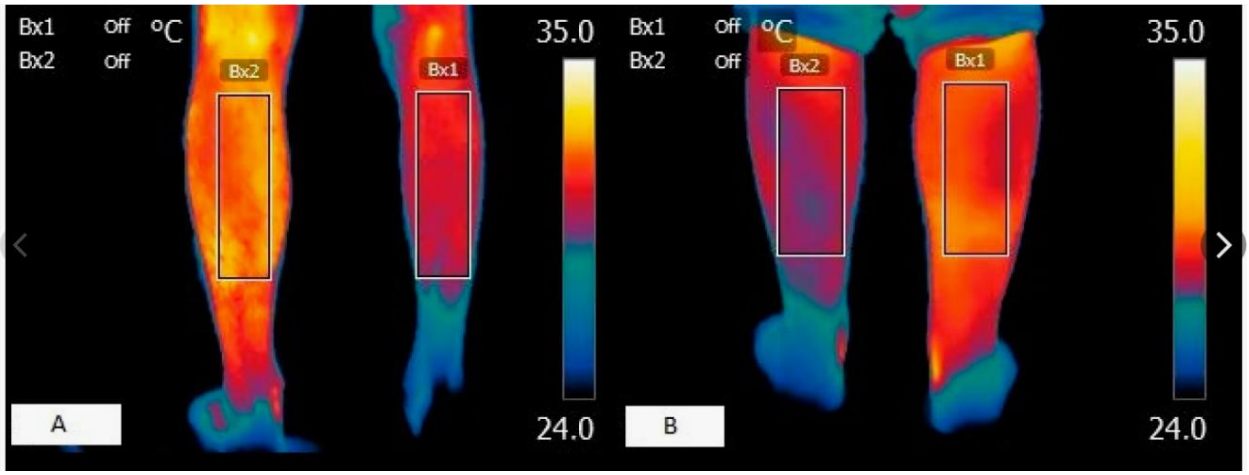
Physiological Basis of Medical Thermography: All objects with temperatures above absolute zero emit infrared radiation according to physical laws of thermodynamics [6]. Human skin continuously emits infrared energy that reflects local blood flow, metabolic activity, and autonomic regulation [3]. Thermal cameras detect this radiation and generate high-resolution thermal images [4].

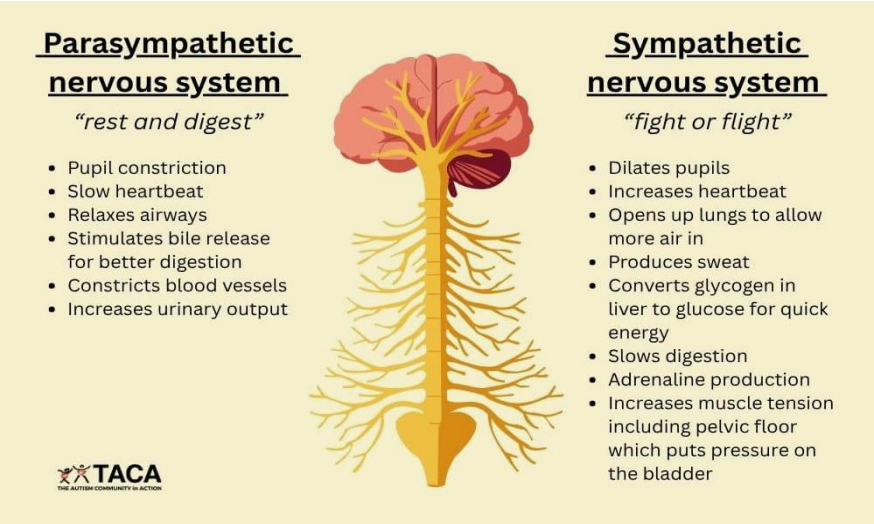
In healthy individuals, skin temperature distribution is generally symmetrical between corresponding anatomical regions [12]. Temperature differences greater than approximately 0.5–1.0°C may indicate pathological processes involving vascular, inflammatory, or neurological dysfunction [3].

The autonomic nervous system plays a major role in thermoregulation through sympathetic control of cutaneous blood vessels [6]. When peripheral or central nerves are damaged, vasomotor regulation may become impaired, leading to localized hyperthermia or hypothermia detectable by thermographic imaging [9].



Mechanisms of Thermal Changes in Neuropathic Pain: Neuropathic pain affects thermal patterns through several pathophysiological mechanisms.

Sympathetic Nervous System Dysfunction: Peripheral nerve injury can disrupt sympathetic vasomotor fibers, producing abnormal vasoconstriction or vasodilation [7]. Increased blood flow may cause localized warming, whereas reduced perfusion may result in cooler skin temperatures.



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Neurogenic Inflammation: Injured sensory nerves release inflammatory neuropeptides that contribute to vasodilation and elevated tissue temperature [9]. These inflammatory changes are often visible as hyperthermic regions on thermographic images.

Central Sensitization: Chronic neuropathic pain may alter central autonomic processing, resulting in widespread dysregulation of thermal homeostasis [2,9].

Microcirculatory Disturbance: Abnormal microvascular perfusion associated with neuropathy may create characteristic thermal asymmetries visualized using infrared imaging [10].

Types of Thermography Used in Clinical Practice

Static Infrared Thermography: Static thermography evaluates baseline skin temperature under standardized environmental conditions and is commonly used to identify thermal asymmetry associated with neuropathic disorders [15].

Dynamic Infrared Thermography: Dynamic thermography assesses thermal recovery following cold or heat stimulation. This method evaluates autonomic vascular reactivity and may improve diagnostic sensitivity [12].

Digital Infrared Thermal Imaging (DITI): DITI combines infrared imaging with computerized quantitative analysis, enabling objective assessment of temperature distribution and thermal gradients [3,4].

Clinical Applications in Neuropathic Disorders

Complex Regional Pain Syndrome (CRPS): Complex Regional Pain Syndrome is characterized by severe pain, edema, vasomotor instability, and autonomic dysfunction [8]. Thermography is particularly valuable in CRPS because temperature abnormalities are closely related to sympathetic dysregulation [7].

Patients in early inflammatory stages often demonstrate hyperthermia, whereas chronic stages may present with hypothermia due to prolonged vasoconstriction [13]. Several studies have reported significant thermal asymmetry in affected limbs of CRPS patients, supporting the role of infrared imaging as an important adjunctive diagnostic tool [7,13].

Peripheral Nerve Injury: Peripheral nerve trauma may impair autonomic innervation and alter regional blood flow [9]. Thermography can visualize abnormal thermal patterns corresponding to injured nerve territories [3].

Studies involving peripheral neuropathic conditions have demonstrated correlations between neuropathic symptoms and thermographic abnormalities [16]. In some cases, thermal imaging may detect dysfunction before structural abnormalities become visible on conventional imaging methods [14].

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Diabetic Peripheral Neuropathy: Diabetic neuropathy is associated with microvascular impairment and autonomic dysfunction [17]. Infrared thermography is increasingly used to identify abnormal plantar temperature distribution and early inflammatory changes associated with diabetic foot complications [10]. Thermographic screening may help identify high-risk areas before ulcer formation develops, thereby improving preventive care and reducing morbidity [11].

Sympathetically Maintained Pain: Sympathetically maintained pain involves pathological interaction between sensory and sympathetic nervous systems [9]. Thermal imaging is valuable because it directly reflects vasomotor instability associated with sympathetic dysfunction [7]. Patients commonly demonstrate localized hot or cold regions corresponding to painful dermatomes or peripheral nerve distributions [13].

Advantages of Medical Thermography: Medical thermography provides several important advantages in clinical practice.

1.Non-invasive examination

No needles, radiation, or contrast agents are required [3].

2. Real-time physiological assessment

Thermography visualizes dynamic functional changes rather than only anatomical structures [4].

3. Safe for repeated use

The absence of ionizing radiation allows repeated monitoring during treatment and rehabilitation [3].

4. Contact-free imaging

Reduces patient discomfort and infection risk [15].

5. Early detection capability

Functional abnormalities may appear before structural damage becomes detectable using MRI or ultrasound [16-25].

Limitations and challenges: Despite its clinical potential, thermography has several limitations.

1.Limited Specificity

Thermal abnormalities are not exclusive to neuropathic disorders and may also occur in infections, vascular diseases, arthritis, and musculoskeletal injuries [4].

2. Operator Dependency

Image acquisition and interpretation require specialized training and experience [15].

3. Complementary Rather Than Definitive Tool

Thermography should not replace conventional diagnostic methods such as electromyography, nerve conduction studies, MRI, or ultrasound [14]. Instead, it should be used as a complementary functional imaging modality [3]

Future perspectives: The future role of thermography in neurology and pain medicine appears promising due to advances in artificial intelligence-assisted image interpretation, machine learning algorithms, portable infrared imaging devices, and quantitative thermal biomarkers [16-31]. Integration of thermography with electrophysiological testing and wearable biosensors may further improve the early diagnosis and monitoring of neuropathic disorders [3].

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Conclusion

Medical thermography has emerged as an important adjunctive technique in the evaluation of neuropathic pain and nerve dysfunction. By detecting abnormalities in skin temperature distribution associated with autonomic dysregulation and microvascular impairment, thermography provides valuable functional information unavailable through many conventional imaging techniques. Current evidence supports its clinical utility in conditions such as CRPS, diabetic neuropathy, peripheral nerve injury, and sympathetically maintained pain. Although limitations regarding specificity and standardization remain, ongoing technological advancements may significantly expand the diagnostic role of infrared thermography in modern medicine.

References

1.Treede RD, Jensen TS, Campbell JN, et al. Neuropathic pain: Redefinition and a grading system for clinical and research purposes. Neurology. 2008;70(18):1630–1635.
2. Colloca L, Ludman T, Bouhassira D, et al. Neuropathic pain. Nat Rev Dis Primers. 2017;3:17002.
3.Ring EFJ, Ammer K. Infrared thermal imaging in medicine. Physiol Meas. 2012;33(3):R33–R46.
4.Lahiri BB, Bagavathiappan S, Jayakumar T, Philip J. Medical applications of infrared thermography: A review. Infrared Phys Technol. 2012;55(4):221–235.
5. Brioschi ML, Yeng LT, Pastor EMH, et al. Documentation of the diagnosis of chronic pain by means of infrared imaging. Acta Fisiatr. 2007;14(1):41–48.
6. Benzinger TH. Heat regulation: Homeostasis of central temperature in man. Physiol Rev. 1969;49(4):671–759.
7. Wasner G, Schattschneider J, Binder A, Baron R. Complex regional pain syndrome: Diagnostic mechanisms, CNS involvement and therapy. Spinal Cord. 2003;41(2):61–75.
8. Bruehl S. Complex regional pain syndrome. BMJ. 2015;351:h2730.
9. Baron R. Mechanisms of disease: Neuropathic pain—a clinical perspective. Nat Clin Pract Neurol. 2006;2(2):95–106.
10.Bagavathiappan S, Philip J, Jayakumar T, et al. Correlation between plantar foot temperature and diabetic neuropathy. J Med Phys. 2010;35(2):85–92.
11.Armstrong DG, Holtz-Neiderer K, Wendel C, et al. Skin temperature monitoring reduces the risk for diabetic foot ulceration. Am J Med. 2007;120(12):1042–1046.
12.Zaproudina N, Varmavuo V, Airaksinen O, Närhi M. Reproducibility of infrared thermography measurements in healthy individuals. Physiol Meas. 2008;29(4):515–524.
13.Sherman RA, Karstetter KW, Damiano M, Evans CB. Stability of temperature asymmetries in reflex sympathetic dystrophy over time and changes in pain. Clin J Pain. 1994;10(1):71–77.
14.England JD, Gronseth GS, Franklin G, et al. Practice parameter: Evaluation of distal symmetric polyneuropathy. Neurology. 2009;72(2):177–184.
15.Ammer K, Ring EFJ. Standard procedures for infrared imaging in medicine. In: Medical Infrared Imaging. Boca Raton: CRC Press; 2019.
16.Jiang LJ, Ng EY, Yeo AC. A perspective on medical infrared imaging in neuromuscular disorders. Quant InfraRed Thermogr J. 2005;2(2):139–155.
17.Tesfaye S, Boulton AJM, Dyck PJ, et al. Diabetic neuropathies: Update on definitions and diagnostic criteria. Diabetes Care. 2010;33(10):2285–2293.

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webofjournals.com/index.php/5

18. Elmurotova D., Urmanbekova D.S., A'zamova G.A. Pathogenesis of cervical cancer // Miasto Prysztosci, IF-9.9, ISSN-2544-980X, V.68, 2026, P.107-112. Poland. https://miastoprzyszlosci.com.pl/index.php/mp/article/view/7364/69256
19. Elmurotova D.B., Kattaxodjayeva D.U., Ibragimova G.J., Zaxidov M.Sh. Means of early detoxification of the irradiated organism // Miasto Prysztosci, IF-9.9, ISSN-2544-980X, V.68, 2026, P.194-197. Poland. https://miastoprzyszlosci.com.pl/index.php/mp/article/view/7392/6952
20. Elmurotova D.B., Boysariev A.A. Artificial intelligence in nuclear energy// Miasto Prysztosci, IF-9.9, ISSN-2544-980X, V.69, 2026, P.59-63. Poland. https://miastoprzyszlosci.com.pl/index.php/mp/article/view/7425/6980
21. Elmurotova D.B., Odilova N.J., Allayarova G.X. Effect of low-energy ion implantation on semiconductors // // American Journal of Bioscience and Clinical Integrity, ISSN: 2997-7347, V.3., N.02, 2026. P.79-85. Amerika, https://biojournals.us/index.php/AJBCI/article/view/2070/1729
22. Elmurotova D.B., Odilova N.J., Allayarova G.X. Post-implantation annealing of silicon implanted with alkali metal ions // Eurasian Journal of Physics, Chemistry and Mathematics (EJPCM), Eureka Open Access journals, ISSM 2760-490X, V2, Issue 3, March 2026, P.1-9.
23. Elmurotova D.B., Imanova L.N., Yoqubboyeva E.Z., Orifqulova M.F. History and application of laparoscopic equipment // Eurasian Journal of Physics, Chemistry and Mathematics (EJPCM), Eureka Open Access journals, ISSM 2760-4942, V2, Issue 3, March 2026, P.17-22.
24. Elmurotova D.B., Urmanbekova D.S., Berdiyev A.I. Main causes of cardiac rhythm disorders // EduVision: Journal of Innovations in Pedagogy and Educational Advancements, V.2, Is 4, 04. 2026, P.173-180.
25. Elmurotova D.B., Nurmatova S.B. Qattiq jismlarda kechadigan fizik jarayonlar// Journal of education, ethics and value. V.5, N.01., ISSN: 2181-4392, 2026. P.5-12. https://jeev.innovascience.uz/index.php/jeev/article/view/1788
26. Elmurotova D.B., Qurbonov J.M., Qõchqorov O.A., G'ayratova Sh.U., Suyunova F.J. Ionlashgan nurlanishlarni kashf etilish bosqichlari // Journal of education, ethics and value. V.5, N.01., ISSN: 2181-4392, 2026. P.92-96. https://jeev.innovascience.uz/index.php/jeev/article/view/1805/1597
27. Элмуротова Д.Б., Курбонов Ж.М., Кахорова Э.И., Жахонгирова П.Б. Физические свойства ионизирующих излучие // Journal of education, ethics and value. V.5, N.01., ISSN: 2181-4392, 2026. P.92-96. https://jeev.innovascience.uz/index.php/jeev/article/view/1806
28. Элмуротова Д.Б., Урманбекова Д.С., Бурхонидинова Ш.Д., Орифжонова Г.М. Ишемическая болезнь сердца // Journal of education, ethics and value. V.5, N.01., ISSN: 2181-4392, 2026. P.115-118. https://jeev.innovascience.uz/index.php/jeev/article/view/1810/1601
29. Элмуротова Д.Б., Каттаходжаева Д.У., Ибрагимова Г.Ж., Хожаназарова С.Ж. Механизмы поражающего действия ионизирующих излучений // Journal of education, ethics and value. V.5, N.01., ISSN: 2181-4392, 2026. P.119-124. https://jeev.innovascience.uz/index.php/jeev/article/view/1811/1602
30. Элмуротова Д.Б., Бойсариев А.А. Искусственный интеллект для ядерной энергетики // Journal of education, ethics and value. V.5, N.01., ISSN: 2181-4392, 2026. P.119-124. https://jeev.innovascience.uz/index.php/jeev/article/view/1811/1602
31. Elmurotova D.B., Urmanbekova D.S., Berdiyev A.I. Yallig`lanish etiologiyasi va mediatorlari // Journal of education, ethics and value. V.5, N.03., ISSN: 2181-4392, 2026. P.30-34. https://jeev.innovascience.uz/index.php/jeev/article/view/1857/1642.

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